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ADP017718

TITLE: Russell Road Landfill Virginia's First Subtitle C Landfill Closure

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This paper is part of the following report:

TITLE: Proceedings of the Tri-Service Environmental Technology Workshop, "Enhancing Readiness Through Environmental Quality Technology" Held in Hershey, PA on 20-22 May 1996

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ADP017697 thru ADP017729

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**RUSSELL ROAD LANDFILL
VIRGINIA'S FIRST SUBTITLE C LANDFILL CLOSURE**

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ABSTRACT

OHM Remediation Services Corp. (OHM), a wholly owned subsidiary of OHM Corporation, located in Richmond, Virginia under the Navy LANTDIV Multi-Contaminant Remedial Action Contract (RAC) is constructing a multi-layer composite cap over the 28-acre Russell Road Landfill at the Marine Corps Combat Development Command (MCCDC) in Quantico, Virginia. Completion of this project will mark the first closure of a Subtitle C (hazardous waste) landfill in the Commonwealth of Virginia. The composite cap layers from top to bottom are: topsoil, frost protection layer, filter/separation geotextile, stone drainage layer, cushion geotextile, 60-mil high-density polyethylene (HDPE) (both smooth and textured), Geosynthetic Clay Layer, and common subgrade.

Significant achievements during the course of the project included: Installation of sediment control structures that protected adjacent waterways and wetlands from 60 disturbed acres of construction activities; the acceptance by the Commonwealth of Virginia of value engineered changes to the Closure Plan and the cap design; "clean-closure" of seven areas adjacent to the cap; and the installation of 6,000 linear feet of leachate collection system averaging 20 feet below existing grade, and in some cases through 6 feet of bedrock. A large portion of the excavations were performed in Level B (supplied air) due to the unknown nature of the landfill subsurface.

The paper outlines the steps taken to successfully complete this design-build contract from site investigation through close-out report including a description of RAC processes emphasizing team built solutions between owner, contractor and regulators to maintain flexibility in the field. Additionally, the paper outlines the submittal and review process between the remedial contractor and the Virginia Department of Environmental Quality (VADEQ).

Detailed description of value engineered solutions include: Development of a 13-acre on-site borrow area; the identification of cap limits based on existing above-ground and subsurface conditions; and the use of geosynthetic clay liner in lieu of a 24-inch compacted clay layer, the redesign of a leachate collection system, and modification of project specifications to emphasize constructability of the cap.

1. INTRODUCTION

This paper describes work performed in the closure of the Russell Road Landfill. The project is being executed under the Naval Facilities Engineering Command's RAC awarded to OHM in 1993. This project was the 45th of the over 100 delivery orders issued to OHM to date, and at the time of the award was the largest undertaking of the RAC program. Prior to OHM's involvement, several years of study and design were performed, resulting in the selected remedy for this site. This paper is a case study in the closure process, from problem identification to execution of the remedy. The structure of the program is described as a framework for discussion on the execution methodology and technical decision-making that has led to a successful project.

2. RAC CONTRACT

The Russell Road Landfill project was awarded under the RAC. The RAC was specifically developed to conduct environmental cleanup and restoration projects at identified hazardous waste sites on Navy and Marine Corps installations, as well as other government sites. In this case, a Firm Fixed-Price contract was inappropriate since the project scope was not completely definable until work was already in progress. The program was selected as the contract mechanism since it is a Cost-Reimbursable/Award Fee contract, under which the Contractor is reimbursed for all reasonable costs incurred during the project. Contrary to the potentially adversarial relationship of a Firm-Fixed-Price contract, the RAC causes the contractor and the government to share risk. The award fee is used as an incentive for the Contractor to control costs while producing effective results. The Atlantic Division (LANTDIV) of the Naval Facilities Engineering Command (NAVFAC) awarded the multi-contaminant RAC to OHM based on their qualifications and experience in the remediation field.

There are many key personnel involved in each RAC Delivery Order. The main supervisor for the project is the Contractor. He is responsible for execution of a successful project in the field and for reporting accurate cost and schedule impacts on a regular basis to the Navy's representatives. In addition monthly updates are submitted to the Government which detail items such as progress in the field, re-work items, costs incurred, and predicted cost savings or over-runs, and Health and Safety statistics.

The Navy's on-base Resident Officer in Charge of Construction (ROICC) also has two representatives involved in the project: the Navy Technical Representative (NTR) and a Project Inspector. The NTR and the inspector are responsible for technical oversight of the project, and the enforcement of the contract plans and specifications. In addition, the NTR reviews the Contractor's monthly status reports and invoices, and provides input on the Contractor's award fee percentage at periodic intervals. Another important government representative is the Remedial Project Manager (RPM), who is usually located at the Engineering Field Division/Activity (EFD/EFA) level. He ensures compliance with Navy Policy, Guidance, and Environmental Laws and Regulations. He also provides technical input and obtains appropriate funding for the project.

The NTR and RPM report to the Contracting Officer's Technical Representative (COTR), also at the EFD/EFA level. The COTR has the chief responsibility for technical oversight of the contract. He also reviews the Contractor's status reports, monitors the project cost, and presents the award fee evaluation comments to the Technical Evaluation Board. Neither the NTR, the RPM, nor the COTR have the authority to change the cost or scope of the project. This responsibility lies with the Contracting Officer for the Delivery Order. If the project scope changes or if there is a significant increase or decrease in cost, the Contracting Officer will issue a modification to the delivery order accordingly.

3. AREA DESCRIPTION

The MCCDC is located within southern Prince William, northern Stafford, and eastern Fauquier Counties of Virginia, 35 miles south of Washington, D.C., and has an area of approximately 56,000 acres. The principal mission of the facility is training of Marine Corps and FBI personnel, and research, development, testing and evaluation of military hardware.

The base was activated in 1917, in time for World War I. The base has had major expansions that occurred during World War II, Korea, and Vietnam War Eras. The base is currently undergoing an increase in activity and personnel as a result of Base Realignment and Closure.

The base was proposed for the National Priorities List on May 10, 1993, and placed on the list on June 30, 1994. The base first submitted a notification of Hazardous Waste Activity on September 15, 1981. Quantico was first listed on the Hazardous Waste Compliance Docket in 1982. The base was granted Interim Status in 1983. The Department of Defense (DOD) Installation Restoration (IR) program began in 1984 with the completion of an Initial Assessment Study.

4. SITE DESCRIPTION

The landfill was established in 1960 and used for 22 years by all organizations on MCCDC. The areal extent is 28 acres, situated in roughly a triangle, with the base being approximately 1,100 feet and the length approximately 2,700 feet. The landfill is located along a former ridge that has been flattened, by landfill operations, into a plateau. The landfill was constructed via trench and fill methods, with two to four layers of trash being placed in the trench. Materials in the landfill include paint, waste oils, automobile batteries, photographic chemicals, construction debris, tires, scrap metal, petroleum contaminated soils, medical waste, and bituminous materials.

The landfill was originally closed in June 1983, under agreement with the State of Virginia. In December 1989, MCCDC was inspected by the Virginia Department of Waste Management. During the inspection, several violations were noticed, and a Notice of Violation was sent on April 12, 1990. As a result of negotiations between the State of Virginia and the Marine Corps, a Federal Facilities Compliance Agreement was signed in November 1991. This agreement stated that MCCDC would agree, among other things, to close four Resource Conservation and Recovery Act (RCRA) disposal units. One of the four units is the Russell Road Landfill.

5. BACKGROUND

In 1989, the Navy contracted with Ensafe, Allen and Hoshall to design the closure. The plan, approved in January 1995, called for a 2-foot layer of clay, 40-mil of very low-density polyethylene (VLDPE) liner, 1 foot of fine stone, and then 2 feet of common fill. The landfill was to be ringed by a 2-foot-wide, 20-foot-deep leachate collection trench that would gravity flow to two collection sumps. The limits of the landfill were determined by photo interpretation, and some magnetometer surveys.

The Navy contracted with OHM for the cap construction in February 1995. The team then began the constructability review process with the objective of developing detailed shop drawings. This led to design modifications that proved to reduce construction costs.

6. REGULATORY REQUIREMENTS

The landfill is a landfill as defined in Virginia Hazardous Waste Management Regulations (VHWMR) Part 2.102, or 40 Code of Federal Regulations (CFR) 260.10. The Closure Plan met all the requirements of VHWMR 672-10-1 Part X Section 10.13 and provided for a leachate collection system, a multi-layer cap, a gas vent system, and long-term maintenance.

Remedy selection was limited by the regulations to the types of capping material that would be used. Through partnership and communication with the VADEQ, several innovative materials and techniques were used.

7. PRE-CONSTRUCTION SITE INVESTIGATION

OHM and the Navy made a joint site inspection during May 1995. It was suspected at that time that the actual limits of waste appeared to exist outside the limits shown on construction drawings. The Closure Plan specified a leachate collection trench that would encompass all waste at an average depth of 20 feet below existing grade.

The system was specified to be a gravity system that discharged leachate to two sumps located at the southern end of the landfill. In order to develop a trench profile, an accurate location of waste limits and depth was critical.

Therefore, 126 test pits were dug on 100-foot centers around what was thought to be the perimeter of the trash placement area of the site. Pits were excavated from the existing treeline, outward or inward, until the visual extent of trash was located. The locations were then surveyed, and this data was used during the redesign effort. The limits were flagged and later surveyed.

As test pit information was gathered, it was discovered that waste extended much further to the south and in close proximity to a local road. Rather than backfilling the test pits then re-excavating approximately 30,000 cubic yards of waste, this waste was immediately relocated to within the landfill. When excavation was completed, the area was sampled and recommended for RCRA closure.

In addition to changes in the location of waste, the existing topography around the perimeter of the landfill varied from that shown on the construction drawings. A complete site survey was performed and the confirmed limits of waste were plotted. While mobilization activities were intensified and the installation of sediment control features was initiated, engineers were reviewing the results of the field investigation and beginning to create construction level drawings. With site preparation in full-swing, a revised Closure Plan was being modified for submission to the VADEQ.

8. DESIGN MODIFICATIONS

What started as the development of shop drawings and work plans grew to significant modification of the design. The changes were motivated by several factors: 1) the discovery of inconsistencies between maps showing existing conditions and current site topography; 2) the results of test pits excavated to determine the actual limits of waste; 3) the identification of potential borrow sources immediately adjacent to the landfill; 4) the successful use on Geosynthetic Clay Liners (GCLs) in lieu of clay on other projects; and 5) the need to develop a new profile for the leachate collection system, consistent with actual field conditions and vertical waste location.

Once it was determined that the incorporation of these changes would require a resubmission of the Closure Plan, the project team embarked on a complete and comprehensive modification to the design package. Significant changes made were: the replacement of 60-mil HDPE for 40-mil VLDPE; the replacement of two concrete leachate sumps with one double-walled HDPE leachate sump, a revision to the tie-in detail between the leachate trench liner and the cap liner; the replacement of 10-ounce geotextiles above and below the stone drainage layer, with 8- and 16-ounce, respectively; redesign of the leachate collection system; and perhaps most significantly, the identification of seven areas where, after waste would be removed from outside the proposed leachate trench and verification samples were returned, "clean closure" certification would be sought. Table 1 highlights the changes made and the benefits gained. Table 2 shows the design considerations necessitated by the changes.

New maps were generated and the project engineers began to design erosion control features that fit the actual site topography. The design utilized the rolling features of site to minimize earthmoving operations during the construction of basins and channels. Basins were formed by, wherever possible, construction of a berm/dike across an existing valley. Additionally, the structures had to be placed where they would not be a hindrance to any of the construction activities that were proposed (such as the leachate collection trench and the cap liner trench). Anticipating sediment flows from over 60 acres of disturbed land, OHM focussed on providing low maintenance structures and designed the structures to contain 150% to 200% of the required capacity. This ensured that in the event of a major storm event the basins would not overflow and would contain all the sediment and site runoff.

The installation of six sedimentation basins, one sediment trap, and over two miles of trenches and swales made up the majority of the 1995 work season. Utilizing as many natural features as possible, the total capacity for water retention was approximately 5,000,000 gallons. Moving berms constructed throughout the site diverted water away from open excavations, and the daily application of soil over exposed waste, prevented the migration of contamination of the site via surface water.

TABLE 1. CHANGES TO DESIGN

NEW CAP CROSS-SECTION

| ORIGINAL DESIGN | MODIFIED DESIGN | BENEFITS TO CHANGE |
|-----------------|-----------------|---|
| | | <ol style="list-style-type: none"> 1) 10 oz. fabric was replaced with 8 oz. fabric. The fabric functions as a separation layer and filter layer. The materials are lower priced and are adequate for their function. 2) 10 oz. fabric was replaced with 16 oz. fabric. Heavy fabric was needed to withstand construction loads and to protect the liner. 3) 40 mil VLDPE was not available. The switch to 60 mil HDPE was motivated by questions of regulatory acceptance of 40 mil. |

NEW LEACHATE TRENCH CROSS-SECTION

| ORIGINAL DESIGN | MODIFIED DESIGN | BENEFITS TO CHANGE |
|-----------------|-----------------|--|
| | | <ol style="list-style-type: none"> 1) Liner trench separated to facilitate staged construction. 2) The excavation was benched to facilitate installation of the trench materials and for safety reasons. 3) Cleanouts were installed at 400 foot centers to allow for removal of any plugs within the collection system. 4) Placement of geotextile to prevent binding/clogging of the drainage. 5) The trench was redesigned to ease construction. |

NEW ANCHOR TRENCH CROSS-SECTION

| ORIGINAL DESIGN | MODIFIED DESIGN | BENEFITS TO CHANGE |
|-----------------|-----------------|---|
| | | <ol style="list-style-type: none"> 1) The drainage layer was keyed into the cap anchor trench. 2) Placement of lateral drains prevent blowouts of the trench. 3) Placement of geotextile to create a filter for the drainage stone, to prevent clogging. 4) Enhances long term stormwater management. |

TABLE 1. CHANGES TO DESIGN (continued)

| NEW LEACHATE TRENCH CROSS-SECTION | | |
|--|---|--|
| ORIGINAL DESIGN | MODIFIED DESIGN | BENEFITS TO CHANGE |
| <p>LEACHATE COLLECTION SYSTEM</p> <p>SUMP (TYP.)</p> | <p>CLEANOUT (TYP.)</p> <p>SUMP LOCATION</p> <p>LEACHATE COLLECTION SYSTEM AND PROPOSED LIMITS OF RELOCATED/GRADED WASTE</p> | <ol style="list-style-type: none"> 1) Elimination of one sump. Single discharge/alarm. Elimination of one potential spill point. Placed to allow for easy access from paved road. 2) A concrete sump was replaced by a prefabricated HDPE sump. HDPE is a less expensive material and is more resistant to leachate breakdown. 3) Relocation of waste saved costs associated with extending the cap to encompass all of the waste fingers. 4) Cleanouts added. |
| REVISED GRADING | | |
| ORIGINAL DESIGN | MODIFIED DESIGN | BENEFITS TO CHANGE |
| | | <ol style="list-style-type: none"> 1) Flow paths were shortened by reggrading the landfill. Shortened flow paths minimize potential blowouts in the cap anchor trench. 2) Increase in grade hastens the discharge of water and reduces the potential for infiltration, which could help induce a cap failure. 3) Grade adjustments allowed for better stormwater management, due to more water reaching the perimeter drainage channels, which then would be conveyed to the sediment control structures for final removal from the site. |

TABLE 2. MODIFICATIONS AND ISSUES

| Modification | Issues |
|--|---|
| 1) GCL in lieu of Clay | <ul style="list-style-type: none"> 1) Verification of leachate production by running HELP Model. 2) Verify slope stability of all liner materials by performing direct shear testing. 3) Screen borrow soils to prevent damage to GCL fabric via penetration. 4) GCL minimizes the required QA/QC inspection and testing during installation |
| 2) Eliminate Sump | <ul style="list-style-type: none"> 1) Capacity of single sump can contain 30 days of leachate generation. Based on HELP Model. 2) Longer flow path to sump requires change to pipe profile. 3) Placement of second sump would have been difficult if not totally impossible, due to site topography. 4) New waste depths allow for use of single sump. Due to change in condition and vertical location of waste from originally shown. |
| 3) Fabric change from 10 oz. to 8 oz. | <ul style="list-style-type: none"> 1) Evaluate puncture resistance of fabric. 2) Evaluate shear strength due to settling. 3) 8 oz. fabric is normally used in separation layer. 4) 10 oz. fabric is not common and can require additional time to procure. |
| 4) Fabric change from 10 oz. to 16 oz. | <ul style="list-style-type: none"> 1) Evaluate drainage properties of fabric. 2) Added puncture protection 3) 10 oz. fabric is not common. 4) 16 oz. fabric is a more common fabric weight for placement directly over HDPE. |

9. LEACHATE TRENCH DESIGN

The results of test pits provided insight into the actual depth of waste within the landfill, as well as its lateral extent. It became apparent that the proposed grades for the leachate collection system would have to be modified to allow for the leachate collection system to function as originally designed. Additionally, concerns over the constructability of trench configuration were raised. It would be nearly impossible to construct a 24-inch-wide trench to a depth of 20 feet, place a HDPE geomembrane on one wall and a geotextile on the other wall, and then place a perforated HDPE pipe and backfill the excavation. There was no way to seam the HDPE liner sheets together to create the impermeable barrier that was intended in the design. With these concerns in mind, the trench was redesigned.

The most significant impact of the new design was the ability to successfully weld the HDPE liner sheets together. During the excavation of the trench, additional waste that was encountered within the excavation was relocated to within the footprint of the landfill, thereby removing any potential contamination from outside of the landfill.

During redesign of the leachate collection system, engineers proposed the elimination of one of the two leachate sums. This proposal was based on a number of considerations. First, the regulations do not require any specific storage capacity for leachate collection. Second, the placement of a second sum was nearly impossible, due to the topography of the southeastern side of the landfill. Lastly, during the development of the trench profile, engineers were able to convey all collected leachate to a single collection point in the southwest corner of the landfill. This location was ideal because of its proximity to the site access way (facilitating maintenance) and its distance from other construction activity.

Leachate trench construction was initiated along the east border of the site. The final configuration of the trench was shown in Table 1. Included in the Closure Plan were four scenarios under which the leachate trench installation would progress for the possible subsurface conditions. For instance, provisions were made for cases where waste was encountered outside or below the designed leachate pipe invert.

The leachate trench was installed from the leachate sum in the south to the north. This allowed for the advancement of trench while leachate was collected in the system. Due to the severity of last winter, significant leachate flows were realized. Despite snow clearing activities from the landfill, over 500,000 gallons of leachate were generated. On-site treatment of leachate was not permitted, nor was reapplication of the leachate to the surface of the landfill. As a result, all leachate collected by the system was transported and disposed of off-site.

In addition to complications associated with leachate generation, fractured rock was encountered in the south trench at a depth of 10 feet. The presence of rock slowed installation of the HDPE sum, but was excavated with conventional earthmoving equipment.

10. WETLANDS

A local consultant was contracted to delineate the wetlands surrounding the property. Two streams border the east and west sides of the landfill. The impact to these streams was of paramount concern, both from the migration of sediment during construction and from the encroachment of proposed sediment control structures. The sediment basins were designed to minimize the impact to wetlands. As a result of the wetlands delineation, engineers could confirm that less than 1 acre of wetlands would be impacted. In addition to the environmental benefits realized, the quantity of wetlands impacted fell within the Corps of Engineer's Nationwide permit exemption, therefore obviating the need for an individual 404 Wetlands Permit.

11. BORROW AREA

OHM began an investigation to determine if a viable source of clay existed on site, and whether the available material could meet the project specifications and VADEQ regulations. After an exhaustive search of the site and the adjoining property, a potential borrow site was identified. Geotechnical testing was performed to classify the

soil and to determine its suitability for use as the clay barrier layer and to confirm that sufficient volume was available on site. Test pits were excavated within a 13-acre parcel of land located along the west side of the site. The results confirmed that, while the soil was not suitable for use as clay barrier material, it would be a sufficient quantity of material suitable for subgrade and frost protection soils. This discovery yielded a cost savings to the Navy and eliminated the need to import approximately 100,000 cubic yards of soil.

12. GEOSYNTHETIC CLAY LINER

During discussions with VADEQ, interest was expressed in the use of alternate products that would improve cap performance and save the government money. The VADEQ enthusiastically supported a proposal to substitute GCL for off-site clay. Potential savings were now quite significant since the search for an on-site source of clay was not successful. An equivalency review was performed to verify that the proposed GCL would meet all of the requirements of the clay. Additionally, a testing program was undertaken to determine strength parameters of the GCL and between each layer of the composite cap.

13. WASTE RELOCATION AND CLEAN CLOSURE

As previously mentioned a test pit investigation uncovered waste placement outside previously defined limits. Waste placement was determined to follow the landfill perimeter treeline in most cases. According to the original approved closure Plan for the project, no waste was to be relocated. Extending the cap limits to include these seven areas of waste outside the cap limits would increase its size by approximately 25% and would require the cap to extend over a local road.

Economic analysis demonstrated that the relocation of waste and subsequent "clean closure" of the relocation areas benefitted the project when compared to the prospect of extending leachate trench and cap around these areas. Clean closure of these areas being evaluated by comparison to background soils in accordance with SW846 criteria.

14. WASTE REGRADING

In addition to the movement of waste from outside the cap to within the landfill, waste was relocated within the landfill. The landfill was reshaped to an average 3% grade. Over 60,000 cubic yards of waste were moved within the landfill to achieve final waste grade. Above the regraded waste, a 12-inch grading layer will be applied as final subgrade. The final 6 inches of subgrade will be screened to insure that no soils in excess of 2 inches in diameter would be placed. This was a measure taken to ensure that the GCL would not be subject to puncture stresses.

15. ALTERNATIVE PRODUCTS

It is estimated that the use of a GCL in lieu of importing clay will save the project in excess of \$500,000. Factors contributing to this savings include material and installation costs that are lower than the delivered and installed costs of clay. In addition, the placement of GCL occurs immediately prior to geomembrane placement which mitigates the risks due to variations in weather inherent with clay placement. The VADEQ enthusiastically supported this alternative.

16. CONTRACT MANAGEMENT

With so many people involved in the administration of the RAC, teamwork is a necessity. Design build contracts require the simultaneous input from many interests. This project involved the NTR, RPM, Project Inspector, and a representative from Quantico's Natural Resources and Environmental Affairs Branch (NREAB). Weekly meetings with all government personnel guaranteed the best opportunity that all interests would be met. Frequent visits by the VADEQ assisted in plan development, but more importantly, established mutual trust and cultivated the working relationship.

CONCLUSIONS

Coordination with Regulators. The project team has developed an open relationship with the VADEQ. This relationship was fostered during the decision to modify the existing Closure Plan. A measure of confidence was established with the regulators that permitted the preliminary stages of construction to commence in advance of the approval of the revised Closure Plan. While a certain amount of risk is assumed, that risk is mitigated by understanding the regulators' objectives for the project. This could not happen without open and frequent communication.

While it is impossible to anticipate all field conditions, particularly during the excavation of a landfill, it was helpful to include a number of scenarios in the Closure Plan. The scenarios described proposed solutions under a number of different waste configurations. During the excavation of the leachate trench, the actual location and depth of waste would determine the quantity of excavation associated with the leachate collection system installation.